

Motivating Arrays

```
final String
    karen = "Karen Smith",
    john = "John Duncan",
    paul = "Paul Jacobs",
    suzanne = "Suzanne Enders",
    peter = "Peter Phillips"; // 10 more to come ...

System.out.println(karen);
System.out.println(john);
...
```

Per member repeating tasks

- Generate Comma separated list:

Karen Smith, John Duncan, Paul Jacobs, Suzanne Enders, Peter Phillips

- Generate HTML list emphasizing family names:

```
<ul >
  <li >Karen <emph>Smith</emph></li >
  <li >John <emph>Duncan</emph></li >
  <li >Paul <emph>Jacobs</emph></li >
  <li >Suzanne <emph>Enders</emph></li >
  <li >Peter <emph>Phillips</emph></li >
</ul >
```

Example: int array of primes

```
final int[] primes ❶ = new int[5]; ❷
```

```
primes[0] = 2; ❸
```

```
primes[1] = 3;
```

```
primes[2] = 5;
```

```
primes[3] = 7;
```

```
primes[4] = 11;
```

Related exercises

Exercise 138: Assignment to final variable?

Loop prime values

```
for (int i = 0; i < 5; i++) {  
    System.out.println("At index " + i + ": value == " + primes[i]);  
}
```

Result:

```
At index 0: value == 2  
At index 1: value == 3  
At index 2: value == 5  
At index 3: value == 7  
At index 4: value == 11
```

Mind the limit!

```
for (int i = 0; i < 6; i++) {  
    System.out.println("At index " + i + ": value == " + primes[i]);  
}
```

Result:

At index 0: value == 2

At index 1: value == 3

At index 2: value == 5

At index 3: value == 7

At index 4: value == 11

Exception in thread "main" java.lang. **ArrayIndexOutOfBoundsException: 5**

at qq.arrayex.Motivate.main(Motivate.java:27)

Safer: Using length

```
System.out.println("primes.length == " + primes.length);  
for (int i = 0; i < primes.length; i++) {  
    System.out.println("At index " + i + ": value == " + primes[i]);  
}
```

Result:

```
primes.length == 5  
At index 0: value == 2  
At index 1: value == 3  
At index 2: value == 5  
At index 3: value == 7  
At index 4: value == 11
```

Even better: “for-each” style loop

```
for (final int p: primes) {  
    System.out.println("value == " + p);  
}
```

Result:

value == 2

value == 3

value == 5

value == 7

value == 11

Mind the limit, part two

```
final int[] primes = new int[5]; // Last index is 4 rather than 5!
```

```
primes[0] = 2;  
primes[1] = 3;  
primes[2] = 5;  
primes[3] = 7;  
primes[4] = 11;  
primes[5] = 13; // Excessing array limit
```

Result:

```
Exception in thread "main" java.lang.ArrayIndexOutOfBoundsException: 5  
at qq.arrayex.Motivate.main(Motivate.java:25)
```

Primitive data one step initialization

Combining array allocation and value assignment:

```
final int[]  
    primes = {2, 3, 5, 7, 11};
```

```
final int[] primes = new int[5];  
primes[0] = 2;  
primes[1] = 3;  
primes[2] = 5;  
primes[3] = 7;  
primes[4] = 11;
```

Reference data one step initialization

Combining array allocation and value assignment:

```
public class Rectangle {
    private int width, height;
    private boolean hasSolidBorder;
    public Rectangle(int width, int height,
                    boolean hasSolidBorder) {
        this.width = width;
        this.height = height;
        this.hasSolidBorder = hasSolidBorder;
    }
}
```

```
final Rectangle[] rectList = new Rectangle[] {
    new Rectangle(2, 5, true),
    new Rectangle(4, 1, false)
};
```

Related exercises

Exercise 139: Converting string arrays to HTML.

Exercise 140: Route navigation

Exercise 141: Examinations and mark frequencies

Exercise 142: Pangram checker

Array

- Series of objects having identical type.
- Array consists of array elements.
- Element access by index value.
- Holding either primitive types or object references (Class instance or array).
- Contiguous storage in memory.
- Arbitrary array dimensions by virtue of nesting: One-dimensional, two-dimensional etc.

Two syntax variants

1. `type[] arrayName; // preferred`

2. `type arrayName[];`

Array instances are special!

```
... println("    String: " + "".getClass().getName());
... println("    int[]: " + new int[]{}.getClass().getName());
... println("    double[]: " + new double[]{}.getClass().getName());
... println("    boolean[]: " + new boolean[]{}.getClass().getName());
... println("StringBuffer[]: " + new StringBuffer[]{}.getClass().getName());
```

String: java.lang.String

int[]: int[]

double[]: double[]

boolean[]: boolean[]

String[]: java.lang.String[]

StringBuffer[]: java.lang.StringBuffer[]

Array creation details

final String[] shapes

= new String[]{

new String("Triangle"),

new String("Circle")

};

Stack

Heap

Create String instance »Triangle«

Array creation details

final String[] shapes

```
= new String[]{  
  new String("Triangle"),  
  new String("Circle")  
};
```

Stack

Heap

Triangle

Create String instance »Circle«

Array creation details

```
final String[] shapes  
= new String[]{  
    new String("Triangle"),  
    new String("Circle")  
};
```

Stack

Heap

Triangle

Circle

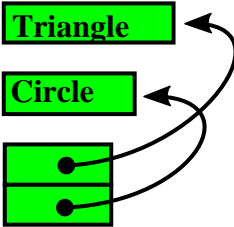
Create array containing two String references.

Array creation details

```
final String[] shapes  
= new String[]{  
    new String("Triangle"),  
    new String("Circle")  
};
```

Stack

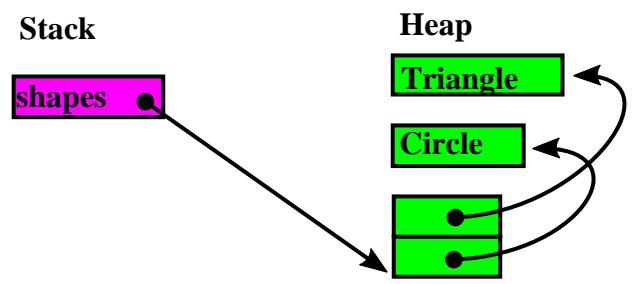
Heap



Create local variable shapes
assigning reference to array.

Array creation details

```
final String[] shapes
= new String[]{
  new String("Triangle"),
  new String("Circle")
};
```



Array parameter passing

```
public static void main(String[] args) {
    final int [] lectures = new int[3]; // Three lectures
    fill(lectures, 25); // Default lecture having 25 participants
    System.out.println("Second lecture has got " + lectures[1] +
        " participants");
}
/**
 * Initialize array with default value.
 *
 * @param values Array to be initialized.
 * @param common New value for all array elements.
 */
static void fill(final int[] values, final int common) {
    for (int i = 0; i < values.length; i++) {
        values[i] = common;
    }
}
```

Second lecture has got 25 participants

Parameter passing details

```
...main(...) {  
  int [] lectures =  
    new int[3];  
  fill(lectures, 25);  
  ...println("Second ..."  
    + lectures[1] +  
    " participants");}
```

Stack

Heap

```
..fill(final int[] values,  
  final int common) {  
  for (int i = 0;  
    i < values.length; i++) {  
    values[i] = common;  
  }}
```

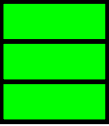
Create int array of size 3.

Parameter passing details

```
...main(...) {  
  int [] lectures =  
    new int[3];  
  fill(lectures, 25);  
  ...println("Second ..."  
    + lectures[1] +  
    " participants");}
```

Stack

Heap



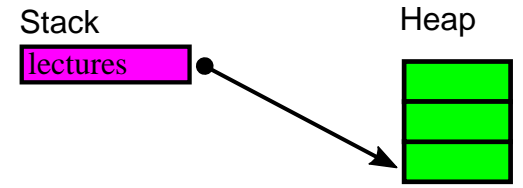
```
..fill(final int[] values,  
  final int common) {  
  for (int i = 0;  
    i < values.length; i++) {  
    values[i] = common;  
  }}
```

Assign array reference to
variable lectures.

Parameter passing details

```
..main(...) {  
  int [] lectures =  
    new int[3];  
  fill(lectures, 25);  
  ...println("Second ..."  
    + lectures[1] +  
    " participants");  
}
```

```
..fill(final int[] values,  
  final int common) {  
  for (int i = 0;  
    i < values.length; i++) {  
    values[i] = common;  
  }  
}
```

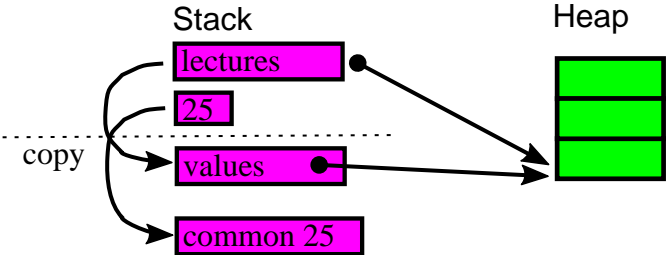


»Call By Value« of fill(...) method
passing both array reference
lectures and primitive int 25.

Parameter passing details

```
...main(...) {  
  int [] lectures =  
    new int[3];  
  fill(lectures, 25);  
  ...println("Second ..."  
    + lectures[1] +  
    " participants");  
}
```

```
..fill(final int[] values,  
  final int common) {  
  for (int i = 0; i < values.length; i++) {  
    values[i] = common;  
  }  
}
```

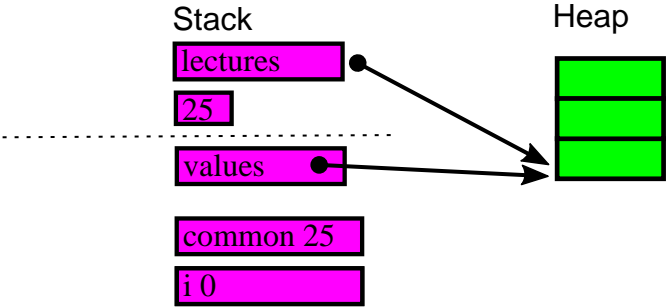


Starting for loop. New local variable i on stack.

Parameter passing details

```
...main(...) {  
  int [] lectures =  
    new int[3];  
  fill(lectures, 25);  
  ...println("Second ..."  
    + lectures[1] +  
    " participants");  
}
```

```
..fill(final int[] values,  
  final int common) {  
  for (int i = 0;  
    i < values.length; i++) {  
    values[i] = common;  
  }  
}}
```

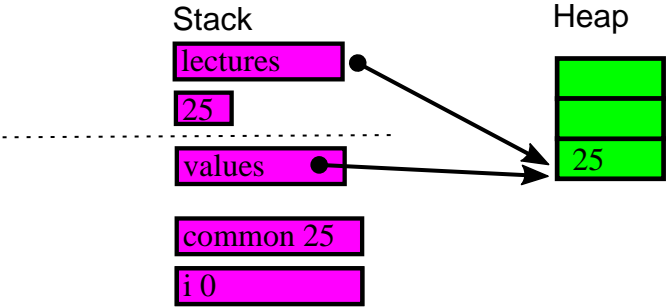


Init first array element to common value.

Parameter passing details

```
...main(...) {  
  int [] lectures =  
    new int[3];  
  fill(lectures, 25);  
  ...println("Second ..."  
    + lectures[1] +  
    " participants");  
}
```

```
..fill(final int[] values,  
  final int common) {  
  for (int i = 0;  
    i < values.length; i++) {  
    values[i] = common;  
  }  
}
```



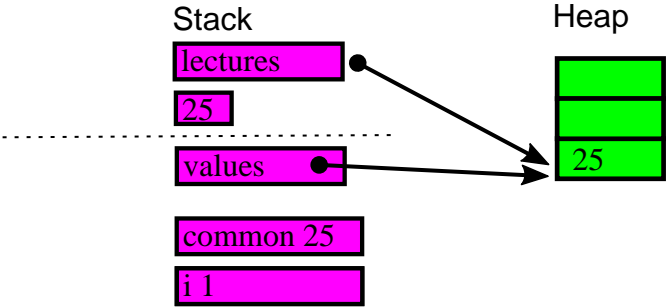
Loop variable increment.



Parameter passing details

```
...main(...) {  
  int [] lectures =  
    new int[3];  
  fill(lectures, 25);  
  ...println("Second ..."  
    + lectures[1] +  
    " participants");  
}
```

```
..fill(final int[] values,  
  final int common) {  
  for (int i = 0;  
    i < values.length; i++) {  
    values[i] = common;  
  }  
}}
```

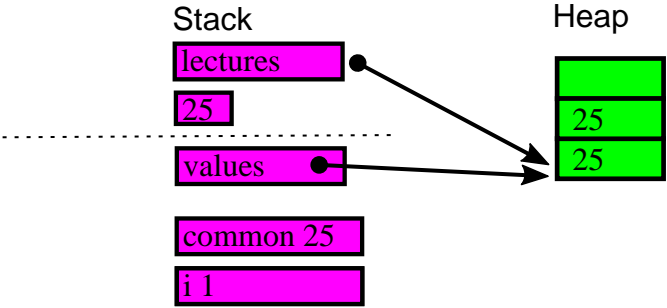


Init second array element to common value.

Parameter passing details

```
...main(...) {  
  int [] lectures =  
    new int[3];  
  fill(lectures, 25);  
  ...println("Second ..."  
    + lectures[1] +  
    " participants");  
}
```

```
..fill(final int[] values,  
  final int common) {  
  for (int i = 0;  
    i < values.length; i++) {  
    values[i] = common;  
  }  
}
```



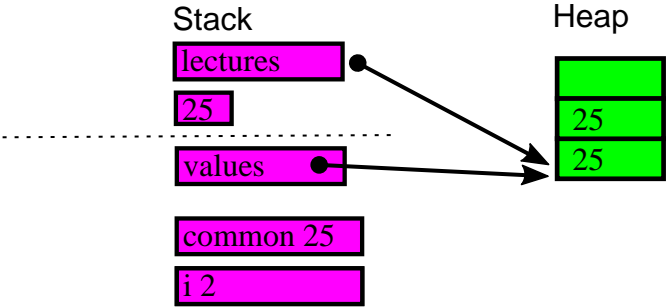
Loop variable increment.



Parameter passing details

```
...main(...) {  
  int [] lectures =  
    new int[3];  
  fill(lectures, 25);  
  ...println("Second ..."  
    + lectures[1] +  
    " participants");  
}
```

```
..fill(final int[] values,  
  final int common) {  
  for (int i = 0;  
    i < values.length; i++) {  
    values[i] = common;  
  }  
}}
```

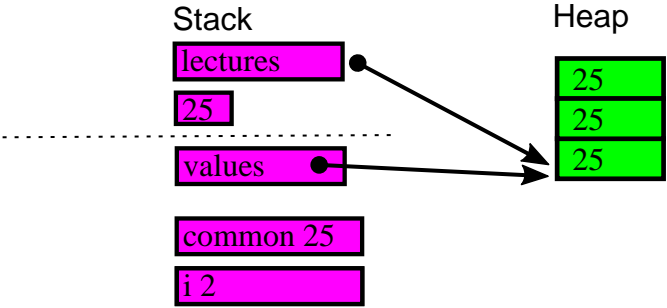


Init third array element to common value.

Parameter passing details

```
...main(...) {  
  int [] lectures =  
    new int[3];  
  fill(lectures, 25);  
  ...println("Second ..."  
    + lectures[1] +  
    " participants");  
}
```

```
..fill(final int[] values,  
  final int common) {  
  for (int i = 0;  
    i < values.length; i++) {  
    values[i] = common;  
  }  
}
```



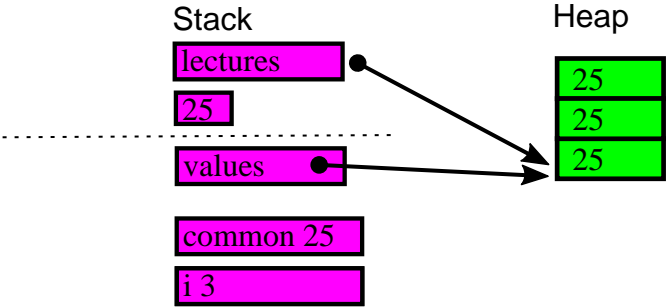
Loop variable increment.



Parameter passing details

```
...main(...) {  
  int [] lectures =  
    new int[3];  
  fill(lectures, 25);  
  ...println("Second ..."  
    + lectures[1] +  
    " participants");  
}
```

```
..fill(final int[] values,  
  final int common) {  
  for (int i = 0;  
    i < values.length; i++) {  
    values[i] = common;  
  }  
}}
```

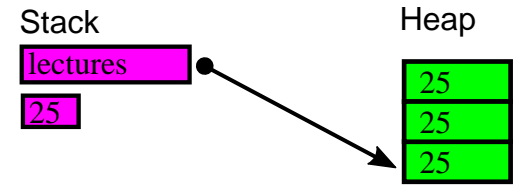


Loop termination, return to main(...)

Parameter passing details

```
..main(...) {  
  int [] lectures =  
    new int[3];  
  fill(lectures, 25);  
  ...println("Second ..."  
  + lectures[1] +  
  " participants");}
```

```
..fill(final int[] values,  
  final int common) {  
  for (int i = 0;  
  i < values.length; i++) {  
    values[i] = common;  
  }  
}}
```



Print second array element.

Value and reference types

```
// Value type  
final boolean values[] = new boolean[]{true, true, false, true};
```

```
// Reference type  
final String shapes[] = new String[]{"Triangle", "Circle"};
```

Same result:

```
final boolean values[] = {true, true, false, true};
```

```
final String shapes[] = {"Triangle", "Circle"};
```

Related exercises

Exercise 143: Reconsidering `System.out.format()`.

Arrays.toString(...) and Arrays.sort(...)

```
final String[] names = {"Eve", "Aaron", "Paul", "Mandy"};
```

```
System.out.println("    toString: " + Arrays.toString(names));
```

```
Arrays.sort(names);
```

```
System.out.println("sort|toString: " + Arrays.toString(names));
```

Result:

```
    toString: [Eve, Aaron, Paul, Mandy]
sort|toString: [Aaron, Eve, Mandy, Paul]
```

Arrays.binarySearch(...)

```
final String[] names = {"Aaron", "Eve", "Mandy", "Paul"};

// Precondition: Array must be ordered!
... println("sort | find(Mand): " + Arrays.binarySearch(names, "Mand"));
... println("sort | find(Mandy): " + Arrays.binarySearch(names, "Mandy"));
... println("sort | find(Mandyer): " + Arrays.binarySearch(names, "Mandyer"));
```

Result:

```
sort | find(Mand): -3
sort | find(Mandy): 2
sort | find(Mandyer): -4
```

Related exercises

Exercise 144: Understanding search results

Arrays.fill(...)

```
final String[] names =  
    {"Eve", "Aaron", "Paul", "Mandy"};
```

```
toString: [Eve, Aaron, Paul, Mandy]
```

```
toString: [N N N N N N]
```

```
System.out.println("toString: " +  
    Arrays.toString(names));
```

```
Arrays.fill(names, "N N");
```

```
System.out.println("toString: " +  
    Arrays.toString(names));
```

Arrays.copyOfRange(...)

```
final String[] names = {"Eve", "Aaron", "Paul", "Mandy"};
```

```
final String[] lastTwoNames = Arrays.copyOfRange(names, 2, 6);
```

```
System.out.println("toString: " + Arrays.toString(lastTwoNames));
```

Result:

```
toString: [Paul, Mandy, null, null]
```


Arrays.equals(...)

```
final String[]  
l1 = {new String("Eve"), new String("Aaron"),  
      new String("Paul"), new String("Mandy")},  
  
l2 = {new String("Eve"), new String("Aaron"),  
      new String("Paul"), new String("Mandy")},  
  
l3 = {new String("Eve"), new String("Aaron"),  
      new String("Paul"), new String("Mobile")};  
  
System.out.println("l1.equals(l2): " + Arrays.equals(l1, l2));  
System.out.println("l1.equals(l3): " + Arrays.equals(l1, l3));
```

Result:

```
l1.equals(l2): true  
l1.equals(l3): false
```

Lack of extendability

```
final String[] member = {"Eve", "John", "Peter", "Jill"};
```

```
final String newCourseMember = "Ernest";
```

```
member.length = 5; // Error: Size unchangeable
```

```
member[4] = newCourseMember;
```

Extending an array

```
public static void main(String[] args) {  
    ❶ String[] member = {"Eve", "John", "Peter", "Jill"};  
    final String newMember = "Ernest";  
    member ❷= append(member, newMember);  
}  
  
static String[] append (final String[] values, final String newValue) {  
    final String[] copy = ❸ new String[values.length + 1];  
    for (int i = 0; i < values.length; i++) { ❹  
        copy[i] = values[i]; ❺  
    }  
    copy[copy.length - 1] = newValue; ❻  
    return copy;  
}
```

Extension result

```
final String[] member = {"Eve", "John", "Peter", "Jill"};
System.out.println("Original array: " + Arrays.toString(member));
final String newMember = "Ernest";
member = append(member, newMember);
System.out.println("Extended array: " + Arrays.toString(member));
```

Original array: [Eve, John, Peter, Jill]

Extended array: [Eve, John, Peter, Jill, Ernest]

Using Arrays. copyOf ()

```
public static void main(String[] args) {
    final int [] start = {1, 7, -4},
    added = append(start, 77);
    System.out.println("added: " + Arrays.toString(added));
}
static public int[] append(final int[] values, final int newValue) {
    final int[] result = Arrays.copyOf(values, values.length + 1);
    result[values.length] = newValue;
    return result;}
}
```

Result:

added: [1, 7, -4, 77]

Related exercises

Exercise 145: Implementing append directly

Exercise 146: Purge duplicates

Exercise 147: A container of fixed capacity holding integer values

Exercise 148: Allow for variable capacity holding integer values

public static void main(String[] args)

```
package myapp;
public class Cmd {
    public static void main(String[] args) {
        for (int i = 0; i < args.length; i++) {
            System.out.println("Parameter " + (i + 1) + ": " + args[i]);
        }
    }
}
```

```
java myapp.Cmd 21 334 -13
```

```
Parameter 1: 21
```

```
Parameter 2: 334
```

```
Parameter 3: -13
```

IntelliJ IDEA run configuration

The screenshot shows the 'Run/Debug Configurations' dialog in IntelliJ IDEA. The configuration is named 'My demo application'. The 'Main class' is 'myapp.Cmd', and the 'Program arguments' are '21 334 -13'. The 'Working directory' is '/ma/goik/C/HdM/Lecture/Incubator/ww'. The 'Configuration' tab is selected, and the 'Code Coverage' and 'Logs' tabs are also visible. The 'Share' and 'Single instance' checkboxes are unchecked. The left sidebar shows the project structure with 'Application', 'My demo application', and 'Defaults' folders.

Run/Debug Configurations

Name: Share Single instance

Configuration | Code Coverage | Logs

Main class: ①

VM options:

Program arguments: ②

Working directory:

IntelliJ IDEA run configuration

The screenshot displays the IntelliJ IDEA interface. At the top, the menu bar includes File, Edit, View, Navigate, Code, Analyze, Refactor, Build, Run, Tools, VCS, Window, and Help. The breadcrumb navigation shows the path: ww > src > main > java > myapp > Cmd. The current file is Cmd.java, and the code editor shows the following Java code:

```
1 package myapp;
2 public class Cmd {
3     @ public static void main(String[] args) {
4         for (int i = 0; i < args.length; i++) {
5             System.out.println("Parameter " + (i + 1) + ": " + args[i]);
6         }
7     }
8 }
9
```

Below the code editor, the breadcrumb navigation indicates the current execution context: Cmd > main(). The Run configuration panel at the bottom shows the configuration name 'Cmd' and the command line: /usr/lib/jvm/java-8-oracle/bin/java ... The output window displays the results of the program execution:

```
Parameter 1: 21
Parameter 2: 334
Parameter 3: -13
```

Creating executable jar

```
<artifactId>naven-shade-plugin</artifactId>
...
<transformer ...>
  <manifestEntries>
    <Main-Class>myapp.Cmd</Main-Class>
  </manifestEntries>...
```

mvn package ...

java -jar target/ww-1.0-SNAPSHOT.jar 21 334 -13

Parameter 1: 21

Parameter 2: 334

Parameter 3: -13

```
unzip ww-1.0-SNAPSHOT.jar
cat tmp/META-INF/MANIFEST.MF
...
Created-By: Apache Maven 3.5.0
Build-Jdk: 1.8.0_151
Main-Class: myapp.Cmd
```

Related exercises

Exercise 149: Reading console input

Exercise 150: Prettifying output representation

Two-dimensional arrays

```
final int[][] matrix = new int[2][3];

for (int row = 0; row < 2; row++) {
    for (int col = 0; col < 3; col++) {
        matrix[row][col] = col + row;
    }
}

for (int row = 0; row < 2; row++) {
    System.out.println(Arrays.toString(matrix[row]));
}
```

Behind the scenes

```
final int[][] matrix = new int[2][]; // Array containing two int arrays
matrix[0] = new int[3];             // first int array
matrix[1] = new int[3];             // second int array
```

Memory allocation

Stack

Heap

```
int[][] matrix = new int[2][];
```

```
matrix[0] = new int[3];
```

```
matrix[1] = new int[3];
```

```
for (int row = 0; row < 2; row++){
```

```
    for (int col = 0; col < 3; col++){
```

```
        matrix[row][col] = col + row;
```

```
    }
```

```
}
```

Memory allocation

Stack

Heap



```
int[][] matrix = new int[2][];
```

```
matrix[0] = new int[3];
```

```
matrix[1] = new int[3];
```

```
for (int row = 0; row < 2; row++){
```

```
    for (int col = 0; col < 3; col++){
```

```
        matrix[row][col] = col + row;
```

```
    }
```

```
}
```

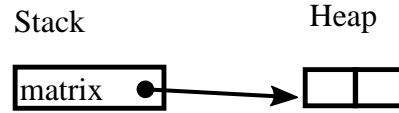
Memory allocation

```
int[][] matrix = new int[2][];
```

```
matrix[0] = new int[3];
```

```
matrix[1] = new int[3];
```

```
for (int row = 0; row < 2; row++){  
    for (int col = 0; col < 3; col++){  
        matrix[row][col] = col + row;  
    }  
}
```



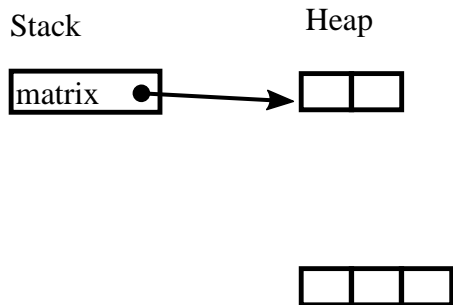
Memory allocation

```
int[][] matrix = new int[2][];
```

```
matrix[0] = new int[3];
```

```
matrix[1] = new int[3];
```

```
for (int row = 0; row < 2; row++){  
    for (int col = 0; col < 3; col++){  
        matrix[row][col] = col + row;  
    }  
}
```



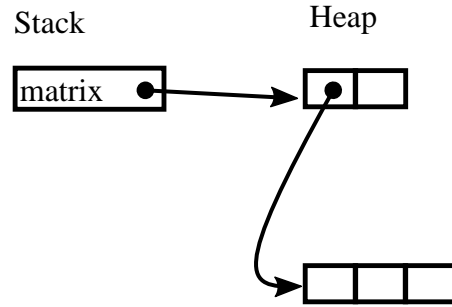
Memory allocation

```
int[][] matrix = new int[2][];
```

```
matrix[0] = new int[3];
```

```
matrix[1] = new int[3];
```

```
for (int row = 0; row < 2; row++){  
    for (int col = 0; col < 3; col++){  
        matrix[row][col] = col + row;  
    }  
}
```



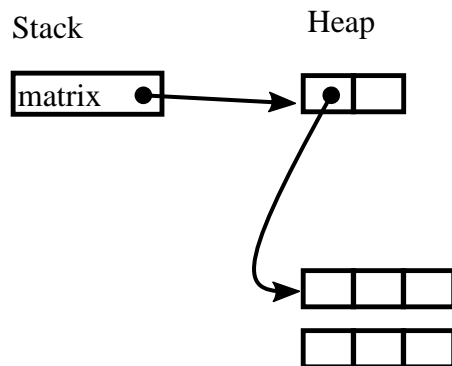
Memory allocation

```
int[][] matrix = new int[2][];
```

```
matrix[0] = new int[3];
```

```
matrix[1] = new int[3];
```

```
for (int row = 0; row < 2; row++){  
    for (int col = 0; col < 3; col++){  
        matrix[row][col] = col + row;  
    }  
}
```



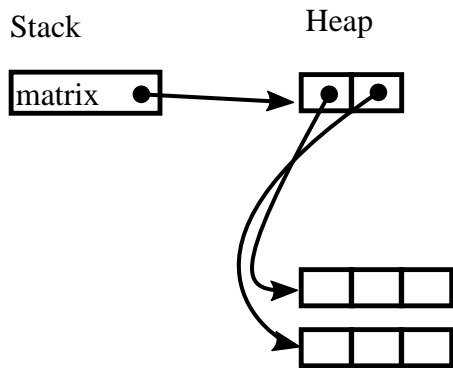
Memory allocation

```
int[][] matrix = new int[2][];
```

```
matrix[0] = new int[3];
```

```
matrix[1] = new int[3];
```

```
for (int row = 0; row < 2; row++){  
    for (int col = 0; col < 3; col++){  
        matrix[row][col] = col + row;  
    }  
}
```



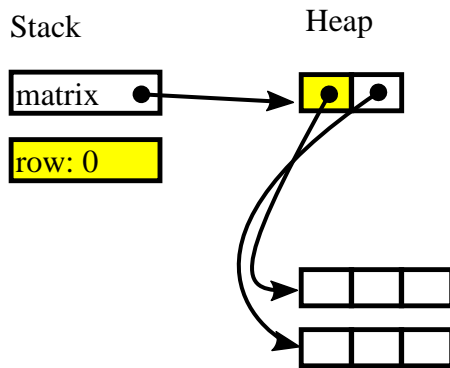
Memory allocation

```
int[][] matrix = new int[2][];
```

```
matrix[0] = new int[3];
```

```
matrix[1] = new int[3];
```

```
for (int row = 0; row < 2; row++){  
    for (int col = 0; col < 3; col++){  
        matrix[row][col] = col + row;  
    }  
}
```



Memory allocation

```
int[][] matrix = new int[2][];
```

```
matrix[0] = new int[3];
```

```
matrix[1] = new int[3];
```

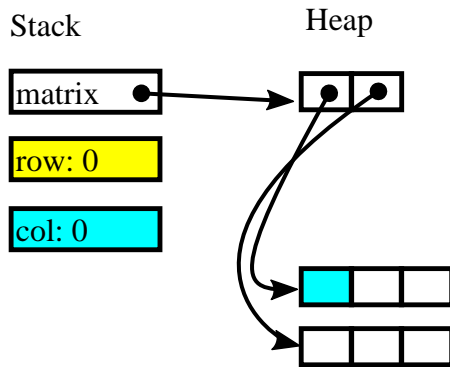
```
for (int row = 0; row < 2; row++){
```

```
    for (int col = 0; col < 3; col++){
```

```
        matrix[row][col] = col + row;
```

```
    }
```

```
}
```



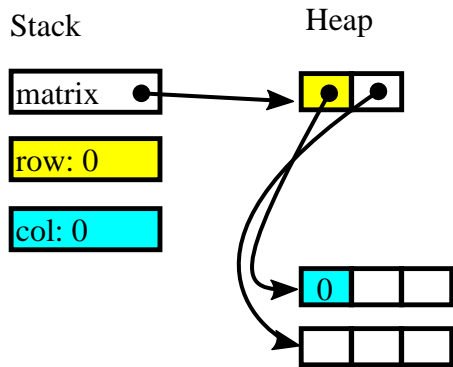
Memory allocation

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int[][] matrix = new int[2][];
```

```
matrix[0] = new int[3];
```

```
matrix[1] = new int[3];
```

```
for (int row = 0; row < 2; row++){  
  for (int col = 0; col < 3; col++){  
    matrix[row][col] = col + row;  
  }  
}
```



Memory allocation

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```

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matrix[0] = new int[3];
```

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matrix[1] = new int[3];
```

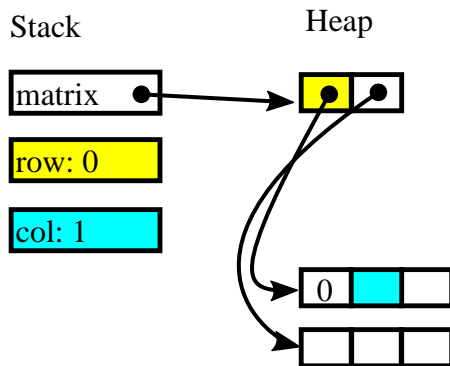
```
for (int row = 0; row < 2; row++){
```

```
    for (int col = 0; col < 3; col++){
```

```
        matrix[row][col] = col + row;
```

```
    }
```

```
}
```



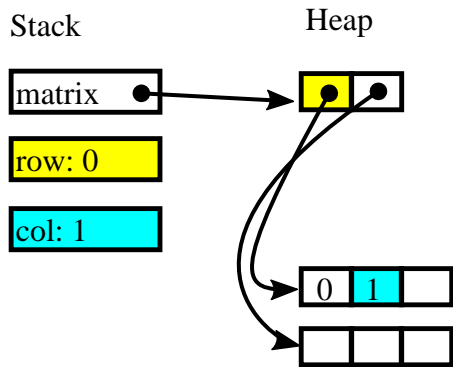
Memory allocation

```
int[][] matrix = new int[2][];
```

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matrix[0] = new int[3];
```

```
matrix[1] = new int[3];
```

```
for (int row = 0; row < 2; row++){  
  for (int col = 0; col < 3; col++){  
    matrix[row][col] = col + row;  
  }  
}
```



Memory allocation

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matrix[0] = new int[3];
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matrix[1] = new int[3];
```

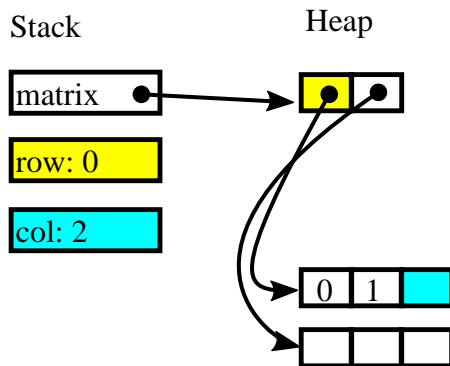
```
for (int row = 0; row < 2; row++){
```

```
    for (int col = 0; col < 3; col++){
```

```
        matrix[row][col] = col + row;
```

```
    }
```

```
}
```



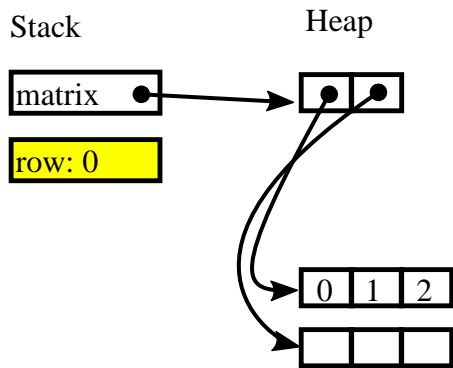
Memory allocation

```
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```

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matrix[0] = new int[3];
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```
matrix[1] = new int[3];
```

```
for (int row = 0; row < 2; row++){  
    for (int col = 0; col < 3; col++){  
        matrix[row][col] = col + row;  
    }  
}
```



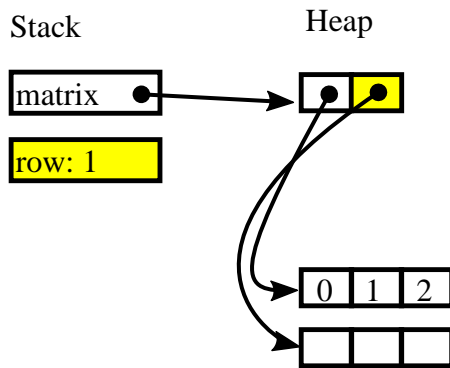
Memory allocation

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int[][] matrix = new int[2][];
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matrix[0] = new int[3];
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matrix[1] = new int[3];
```

```
for (int row = 0; row < 2; row++){  
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    }  
}
```



Memory allocation

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matrix[0] = new int[3];
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matrix[1] = new int[3];
```

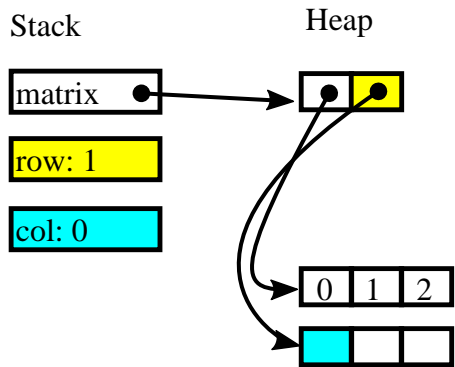
```
for (int row = 0; row < 2; row++){
```

```
    for (int col = 0; col < 3; col++){
```

```
        matrix[row][col] = col + row;
```

```
    }
```

```
}
```



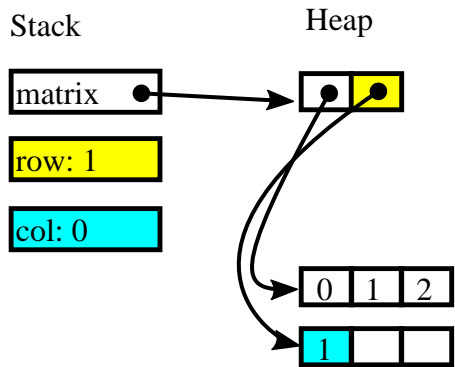
Memory allocation

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  for (int col = 0; col < 3; col++){  
    matrix[row][col] = col + row;  
  }  
}
```



Memory allocation

```
int[][] matrix = new int[2][];
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matrix[0] = new int[3];
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```

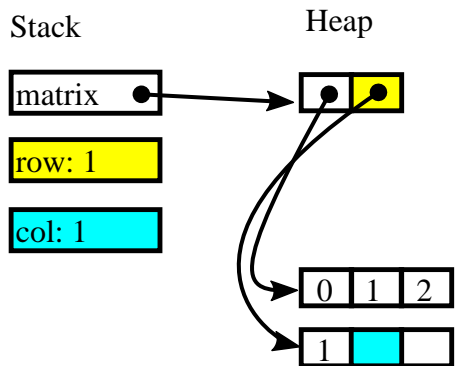
```
for (int row = 0; row < 2; row++){
```

```
    for (int col = 0; col < 3; col++){
```

```
        matrix[row][col] = col + row;
```

```
    }
```

```
}
```



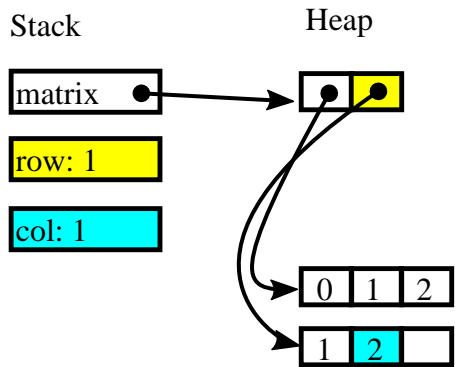
Memory allocation

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matrix[0] = new int[3];
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matrix[1] = new int[3];
```

```
for (int row = 0; row < 2; row++){  
    for (int col = 0; col < 3; col++){  
        matrix[row][col] = col + row;  
    }  
}
```



Memory allocation

```
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```

```
matrix[0] = new int[3];
```

```
matrix[1] = new int[3];
```

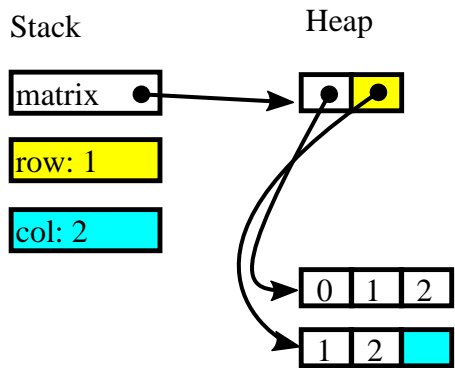
```
for (int row = 0; row < 2; row++){
```

```
    for (int col = 0; col < 3; col++){
```

```
        matrix[row][col] = col + row;
```

```
    }
```

```
}
```



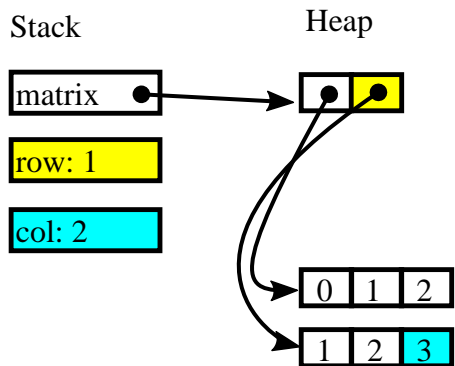
Memory allocation

```
int[][] matrix = new int[2][];
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```
matrix[0] = new int[3];
```

```
matrix[1] = new int[3];
```

```
for (int row = 0; row < 2; row++){  
    for (int col = 0; col < 3; col++){  
        matrix[row][col] = col + row;  
    }  
}
```



Related exercises

Exercise 151: 2-dimensional arrays and `length`

Static array initialization

```
final int[][] matrix = new int[][] {  
    {0, 1, 2},  
    {1, 2, 3}  
};
```

Static array initialization, variable lengths

```
final String[][] groups = new String[][] {
    {"Jill", "Tom"},
    {"Jane", "Smith", "Joe"},
    {"Jeff"}
};

for (int row = 0; row < groups.length; row++) {
    System.out.println(Arrays.toString(groups[row]));
}
```

Related exercises

Exercise 152: External array and string exercises

Exercise 153: Tic-tac-toe using a two-dimensional array

Exercise 154: Changing the game's internal representation

Exercise 155: Tic-tac-toe, Computer vs. human

Exercise 156: Adding support to retrieve statistical data.

Exercise 157: Testing an implementation

Exercise 158: Improving prime number calculation performance

Exercise 159: Calculating the median

Exercise 160: A simple character based plotting application